manner in which the morphological part of the work is treated, one is hardly prepared for the statement that in gymnosperms there is no alternation of generations, although traces of alternation are demonstrable, while in angiosperms the reduction of the prothallium has proceeded so far that sure homologies can no longer be shown and the alternation of generations has entirely disappeared. Of particular interest are the introductory pages on the evolutionary composition of groups, the homologies between them, and the causes of the changes in the homologous organs of the cormophytes.

The bryophytes are subdivided, as usual, into Musci and Hepaticae; in the pteridophytes three groups are recognized, the Filicinae, Equisetinae, and Lycopodinae; the gymnosperms are subdivided into six classes, Cycadinae, Bennettitinae, Cordaitieae, Ginkgoanae, Coniferae, and Gnetinae.—C. J. CHAMBERLAIN.

NOTES FOR STUDENTS.

RENAULT[6] concludes from the study of a number of plant sections that vegetative activity was greater in the Carboniferous age than at present. An extraordinary development of vascular and other tissues is recounted and figured.—H. C. COWLES.

ARBER[7] has recorded *Glossopteris Browniana* Brongn. from Sisi in Rhodesia, the containing formation being probably Permo-Carboniferous. A species of Calamites is recorded from the Tuli coalfield; and the Sengwe coalfield in northern Matabeleland yields an undetermined specimen of wood and two stems of the Eu-Sigillarian Rhytidolepis type.—E. W. BERRY.

MOLLIARD finds[8] that in pure cultures of *Ascobolus sp.* perithecia are not developed, although there is a considerable development of the vegetative mycelium. In all cases of fruiting individuals bacteria are present in abundance. He thinks that this is a fact of large significance, though he has no suggestion as to the exact office of the bacteria in this interesting case of symbiosis.—H. C. COWLES.

SEWARD[9] describes a new species of Dictyozamites from a low horizon in the Estuarine series of the Inferior Oolite of Yorkshire. The genus and its distribution in Jurassic times are discussed somewhat fully, and a comparison is instituted between the lower Mesozoic floras of Japan, Bornholm,

[6] RENAULT, B., Sur l'activité végétative aux époques anciennes. Compt. Rend. **136**: 401–403. 1903.

[7] ARBER, E. A. N., Notes on some fossil plants collected by Mr. Molyneux in Rhodesia. Quart. Jour. Geol. Soc. Lond. **59**: 288–290. 1903.

[8] MOLLIARD, Rôle des bactéries dans la production des périthèces des Ascobolus. Compt. Rend. **136**: 899–901. 1903.

[9] SEWARD, A. C., On the occurrence of Dictyozamites in England, with remarks on European and eastern Mesozoic floras. Quart. Jour. Geol. Soc. Lond. **59**: 217–232. *pl. 15.* 1903.

India, and England, with the result that they show only minor differences facts contrary to the usually accepted view. The paper, which is an important one, concludes with a complete bibliography.—E. W. BERRY.

R. G. LEAVITT[10] has accumulated some interesting data in reference to what he calls reversionary stages in *Drosera intermedia*, stages that he has experimentally induced. These data support the general statement "(1) that reversions, in either an ascending or a descending direction, are sometimes occasioned in plants by a deficiency of the food materials supplied to developing parts; and (2) that reversions in either direction are sometimes occasioned by a superabundant food supply in developing parts."—J. M. C.

BALL[11] has recently reinvestigated the influence of strains upon the formation of mechanical tissue. His results do not agree with those of Hegler on the same subject, for by a gradual increase in the pull exerted upon young stems Ball was able to produce neither an increase in the ability to resist mechanical pulling nor any thickening of the tissues. He substantiates the results obtained by Wortmann and by Elfving that when a stem is inhibited by force from bending geotropically there arises a marked one-sided development of bast fibers and collenchyma on the upper side; and also when an organ is prevented by force from bending phototropically there is a notable increase in the tissues on the side toward which it would bend. An increased thickening was also obtained on the convex side of stems bent over mechanically with gravity neutralized by the clinostat.— W. B. MACCALLUM.

THE DEHISCENCE of sporangia[12] of gymnosperms is definitely related to their form and position, and favors the distribution of the spores. The nearly related Picea and Abies differ in the dehiscence of their sporangia, the dehiscence in Picea being longitudinal while in Abies it is transverse. The upright staminate strobilus of Picea requires a longitudinal dehiscence for a thorough discharge of the pollen, while a transverse dehiscence is more effective in discharging pollen from the drooping strobilus of Abies. The peculiar dehiscence in Taxus is adapted to a rapid discharge of the pollen. In Ginkgo the lines of dehiscence of the two sporangia face each other and lie at such an angle that the pollen is easily shed. Ginkgo is the only known gymnosperm which has an endothecium. The Cupressineae are not considered, because their small, rather spherical sporangia are not so definitely oriented as in the other groups.—C. J. CHAMBERLAIN.

NOEL BERNARD has added further data[13] in the line of his interesting

[10] LEAVITT, R. G., Reversionary stages in *Drosera intermedia*. Rhodora **5**: 265–272. 1903.

[11] BALL, O. M., Der Einfluss von Zug auf die Ausbildung von Festigungsgewebe. Jahrb. Wiss. Bot. **39**: 305–341. *pls. 6–7.* 1903.

[12] GOEBEL, K., Morphologische und biologische Bemerkungen: 13. Ueber die Pollenentleerung bei einigen Gymnospermen. Flora **91**: 237–263. *figs. 19.* 1902.

[13] BERNARD, NOEL, Conditions physiques de la tubérisation chez les végétaux. Compt. Rend. **135**: 706–708. 1902.

tuberization studies.[14] E. Laurent had shown that buds from aerial stems of the potato may develop into tubers, when placed in a sufficiently concentrated solution of saccharose, even when the latter is thoroughly sterilized; which seemed to call in question Bernard's theory that tuberization is due to an infection by parasitic fungi. Bernard confirms Laurent's results and extends them considerably, showing that a number of solutions produce like results. In these cases the chemical nature of the solution is shown to be of but little moment as compared with osmotic pressure. Bernard therefore enlarges his theory as follows: the state of hypertrophy which we call tuberization may be induced by various agents, which bring the cells into contact with substances of relatively high osmotic pressure. Among these substances in nature the products of fungus activity are perhaps the most important.—H. C. COWLES.

IN HIS second paper on the solenostelic ferns Gwynne-Vaughan[15] extends his observations to a large number of genera which he treats in a comparative way. His studies have led him to abandon Van Tieghem's term polystelic, for he finds that the meristeles are in all cases segments of a vascular ring, the lacunae in which are caused by the exit of leaf traces. The term solenostelic is applied to those cases where the foliar lacunae do not overlap, and this condition is derived from one in which the stele is solid. Evidence is adduced to show that the intrastelar parenchyma is merely cortex which has intruded through the leaf-gaps. Thus Gwynne-Vaughan's view of the fern stele coincides with that already advanced by Jeffrey, although rather strangely no mention is made of this fact, and is opposed to that of many English writers. The internal vascular strands found in Cyatheaceae are considered to be derived from elaboration of a local thickening of the xylem ring at the margin of the leaf gaps. The present system of classification is considered to receive support from the anatomical data presented, since nearly all the genera regarded as primitive by Prantl have a primitive vascular structure.—M. A. CHRYSLER.

THE SPERMATOGENESIS of hybrid peas[16] appears as the second paper in Dr. Cannon's studies in plant hybrids. Two hybrid peas were used for the present investigation, one a hybrid between the pure races Fillbasket and Debarbieux, and the other between Express and Serpette. Both hybrids are fertile and show variation according to the law of Mendel. Spermatogenesis was studied both in the pure races and in the hybrids. In the cells of the gametophyte the number of chromosomes is seven in all the pure forms and

[14] See BOT. GAZ. **33**: 75. 1902.

[15] GWYNNE-VAUGHAN, D. T., Observations on the anatomy of solenostelic ferns. II. Ann. Botany **17**: 690–742. 1903.

[16] CANNON, W. A., Studies in plant hybrids: the spermatogenesis of hybrid peas. Bull. Torr. Bot. Club **30**: 519–543. *pls. 17–19*. 1903. For review of the first paper see BOT. GAZ. **35**: 445. 1903.

also in both hybrids. The number of chromosomes in the sporophytes of all the forms is fourteen. In the sporogenous division immediately preceding the formation of the mother-cells in both hybrids and in the pure form Fill-basket, the chromosomes were associated in pairs which may be related to the chromatin rings of the succeeding heterotypic division. Spermatogenesis in the hybrids proceeds just as in the pure races, and no abnormal mitoses were observed; consequently, abnormalities and irregularities of nuclear divisions do not form the basis for the variations of these hybrids. It is suggested that a thorough study of the sporogenous divisions preceding the heterotypic division may afford some explanation of variation.—C. J. CHAMBERLAIN.

AN INTERESTING account of the reproductive processes in Araiospora is presented by King.[17] Zoospores are formed through cleavage with the aid of vacuoles, and the outer plasma membrane is the last connecting film ruptured. The oogonium contains from 35 to 55 nuclei, which pass to the periphery simultaneously with the formation and fusion of patches of fine meshed cytoplasm in the center of the ooplasm. There is probably a general mitosis before the periplasm is differentiated from the ooplasm. A receptive papilla from the ooplasm pierces the antheridium and establishes the canal for the entrance of the sperm nucleus. There is no antheridial tube, the wall of the canal being of oogonial origin. This is a very interesting point, in which Araiospora appears to differ from all other oosporic Phycomycetes. The periplasm divides by anticlinal walls into hexagonal cells which invest the egg. The egg is uninucleate and a single sperm nucleus enters the ooplasm. These gamete nuclei approach in the central region of denser ooplasm and extend toward one another, later rounding off and lying side by side. They were not observed in process of fusion and this event, if it occurs, must be greatly delayed, for the pair may be found in the oldest oospores. The development and structure of the sexual organs indicates a closer relationship of Araiospora to the Peronsporales than to the Saprolegniales.—B. M. DAVIS.

THE REDUCTION of chromosomes, development of the embryo sac, and fertilization in *Paris quadrifolia* and *Trillium grandiflorum* have been investigated by Ernst.[18] The number of chromosomes in Paris is 24 in the sporophyte and 12 in the gametophytes, while in Trillium the numbers are 12 and 6 respectively. Since the two genera are so closely related, it is suggested that the double number of chromosomes in Paris may be due to an extra splitting of the chromatin thread. At the equatorial plate stage of the heterotypic division a second longitudinal splitting of the chromosomes is already

[17] KING, C. A., Observations on the cytology of *Araiospora pulchra* Thaxter. Proc. Boston Soc. Nat. Hist. **31**: 211. 1903.

[18] ERNST, A., Chromosomenreduction, Entwickelung des Embryosackes und Befruchtung bei *Paris quadrifolia* L. und *Trillium grandiflorum* Salisb. Flora **91**: 1–46. *pls. 1–6.* 1902.

evident, so that there can be no reduction division in Weissmann's sense. The statement that Trillium (with Naias) has the smallest number of chromosomes yet known in phanerogams reveals another oversight of American literature,[19] since the numbers in Canna are 6 in sporophyte and 3 in the gametophyte. In a few cases the embryo sac of Trillium showed ten nuclei instead of eight, the two extra nuclei having arisen through fragmentation of two of the eight nuclei.

Double fertilization occurs in both genera. In the union of the sperm nucleus with that of the egg, the fusion is complete, a resting nucleus being formed. The second sperm nucleus and also the two polar nuclei pass into the spirem condition before uniting, so that there can be no real fusion of chromatin in the formation of the endosperm nucleus. How long the chromatin of these three nuclei remains independent was not determined.—C. J. CHAMBERLAIN.

ALL ECOLOGISTS are acquainted with Bonnier's great contributions to experimental anatomy, especially in his studies of alpine plants. He has recently[20] presented a second communication dealing with his Mediterranean cultures, which were established near Toulon in 1898. Fifty perennial species were selected, each plant being split in two, so that cultures of the same individual were conducted at Toulon and Fontainebleau. The plants used were obtained at Fontainebleau, while the soil for the parallel cultures was taken from Toulon. The external characters of the Toulon individuals were noted in the first communication;[21] these characters have been only accentuated in the succeeding seasons, and the experimental plants have become quite like plants of the same species native about Toulon. The early secondary wood at Toulon contains vessels of larger caliber than at Paris, while on the other hand the later wood is more fibrous at the former place. Again, in autumn the Toulon wood contains vessels of large caliber. Bonnier thinks that the large early and late vessels at Toulon are to be correlated with the two rainy periods, while the fibrous wood of summer is correlated with a dry period. Paris, on the other hand, has a more uniform climate, which is moister in summer than that of Toulon. The annual ring is thicker at Toulon. Many differences in leaf structure are also noted; for the most part the Toulon leaf characters are the more xerophytic. The immense importance of this type of study is obvious; it escapes on the one hand the errors arising from hasty field generalizations, and on the other hand it is free from the untenable inferences often drawn from experimental

[19] BOT. GAZ. **30**: 25–47. *pls.* 6–7. 1900. See review in Jour. Appl. Micros. **3**: 1064–1065. 1900.

[20] BONNIER, GASTON, Cultures expérimentales dans la région méditerranéenne pour le modifications de la structure anatomique. Compt. Rend. **135**: 1285–1289. 1902.

[21] Compt. Rend. **129**: 1207–1213. 1899.

work conducted wholly in the artificial conditions of the laboratory or greenhouse.—H. C. COWLES.

IKENO has published his full account of spermatogenesis in *Marchantia polymorpha*,[22] following his preliminary announcement in the *Comptes Rendus*. He finds a centrosome beside each nucleus previous to the mitoses in the spermatogenous tissue. The centrosome divides, and its products, passing to opposite sides of the nucleus, become the poles of the spindle. He gives evidence that the daughter centrosomes sometimes divide again when at the poles of the spindle in anaphase. The centrosome cannot be found at the side of the daughter nucleus after the mitosis is completed, but it appears when the nucleus is ready for the next division. Ikeno believes that the centrosome is formed within the interior of each nucleus as a deeply staining body among the linin threads. This body moves to the nuclear membrane and is thrust from the nucleus. Outside of the nucleus it becomes the centrosome, functioning in the mitosis as described above. This account of the intranuclear origin of a centrosome is extraordinary. Intranuclear centrosomes have been reported in several animal forms, but they do not leave the nucleus in the manner described by Ikeno.

After the final mitoses in the spermatogenous tissue the centrosomes remain, to become the blepharoplasts of the sperms. Each blepharoplast passes to the plasma membrane of its sperm cell and develops two cilia. There is formed at this time another deeply staining body in the cytoplasm considered by Ikeno a *Nebenkörper*. The nucleus begins to elongate, this accessory body takes a position between it and the blepharoplast, and in this manner the much attenuated sperm is organized from the mother-cell.

Ikeno reasserts the blepharoplast to be the homologue of a centrosome, a position which he and Hirasé held in Cycas and Ginkgo respectively. In this they have the support of Belajeff's studies on Marsilia. Of an opposite view are Webber, Strasburger, and Shaw, who hold that there is no genetic relationship between the blepharoplast and the centrosome. The opinions of these authors cannot be discussed in a brief review, but the problem rests on disputed questions of fact as to the origin and behavior of blepharoplasts in all of the great groups of plants, from the processes of zoospore formation to the complications of spermatogenesis in the gymnosperms. There is no agreement on the events in any one type; which is eloquent of the desirability of cell studies of this character.—B. M. DAVIS.

ITEMS OF TAXONOMIC INTEREST are as follows: THEO. HOLM (Am. Jour. Sci. IV. **16**: 369–376. 1903), has made a morphological and anatomical study of *Hypericum virginicum*, often called Elodea, and has reached the conclusion that it represents the obscure but valid genus Triadenum of Rafinesque. Accordingly he writes the name *Triadenum virginicum* (L.) Raf.—THEO.

[22] IKENO, S., Die Spermatogenése von *Marchantia polymorpha*. Beihefte Bot. Centralbl. **15**: 65–88. *pl. 1*. 1903.

HOLM (*idem* 445–464), in his 20th "Studies in the Cyperaceae" has presented a natural classification of *Vigneae* and *Carices genuinae*, illustrating it by numerous species from various parts of the world which have been studied by the author, and were represented by sufficient material. In the *Vigneae* 15 sections are named, all excepting one being new; and in the *Carices genuinae* 24 sections are recognized, 11 of which are new. The classification follows the principles suggested by Drejer.—A. A. EATON (Fern Bull. **12**: 108–114. 1903) has described three new varieties of *Equisetum hiemale*.—H. DE BOISSIEU (Bull. Herb. Boiss. II. **3**: 837–856. 1903), in a paper presenting the Umbelliferae of China, describes *Netopterygium* (Symrnieae) as a new genus with two species, and also new species under Pimpinella, Seseli, Ligusticum, Selinum, Pleurospermum, Angelica, Peucedanum, and Heracleum.—M. L. FERNALD (Rhodora **5**: 247–251. 1903) has described a new Kobresia from Maine.—A. A. EATON (*idem* 277–280) has described three new varieties of Isoetes from Massachusetts.—R. MAIRE and P. A. SACCARDO (Ann. Mycologici **1**: 417–419. 1903) have described a new genus (*Didymascella*) of Phacidiaceae.—GEO. V. NASH (Torreya **3**: 101–102. 1903) has described a new Aletris from Florida.—G. N. BEST (Bull. Torr. Bot. Club **30**: 463–482. *pls. 15–16*. 1903) has published a revision of the North American species of Leskea, recognizing 15 species and varieties, four of which are new.—MARCUS E. JONES (Contrib. Western Bot. 11) has described a new species of Leucothoe, has discussed western Nyctaginaceae, describing a number of new species under Eriogonum, and has presented his views concerning several western Chenopodiaceae, describing new species under Atriplex.—ALICE EASTWOOD (Bull. Torr. Bot. Club **30**: 483–502. 1903), in a paper entitled "New species of western plants," has described new species under Zygadenus, Allium, Fritillaria, Iris, Chorizanthe, Spraguea, Silene, Eschscholtzia (2), Arabis, Cleomella, Wislizenia, Lathyrus, Clarkia, Scutellaria (3), Fraxinus, Convolvulus, Sphacele, Monardella, Lappula, Symphoricarpos (4), Echinocystis, Nemacladus, Agoseris, and Crepis.—O. VON SEEMEN (*idem* 634–636) has described three new species of Salix from California and Nevada.—J. M. C.

RECENT CONTRIBUTIONS CONCERNING MYCORHIZA. Fungi have long been associated with certain liverworts, but NĚMEC[23] was among the first to make a careful study of the subject; it was his belief that they characterize the Jungermanniaceae rather generally, but that they are rare or absent in the Marchantiaceae. STAHL,[24] supposing this distinction to be true, applied his mycorhiza theory to the liverworts, considering the Jungermanniaceae to have weak transpiration, abundance of sugar, and mycorhiza, while the Marchantiaceae have strong transpiration, abundance of starch, and no mycorhiza.

[23] Ber. Deutsch. Bot. Gessells. **17**: 311–317. 1899.

[24] Jahrb. Wiss. Bot. **34**: 539–668. 1900. See BOT. GAZ. **30**: 68. 1900.

GOLENKIN, however, finds[25] that several of the Marchantiaceae, such as Marchantia, Preissia, Fegatella, have typical mycorhiza, although many species appear to be autotrophic. The fungus cells are localized, and in some cases are red in color. Starch is much more abundant in the cells that are free from fungi. BEAUVERIE[26] has made an experimental study of the mycorhiza of *Fegatella conica*, which he thinks to be of benefit to the host. Cultures in which the fungus (a Fusarium) occurs are more luxuriant than sterile cultures. Photosynthesis is weak, and the fungus is believed to obtain some of the necessary carbon. CAVERS[27] has made yet further studies of liverwort mycorhiza, but he adds little to our knowledge.

MÖLLER has been studying[28] the mycorhiza of pine roots, and obtains some results which differ from those of Frank. The well known ectotropic mycorhiza develops in connection with the roots of *Pinus sylvestris* in sand but not in humus, whereas Frank supposed the reverse to be the case. Where the fungus occurs, many of the roots, especially the main roots, are free from it; these roots are abundantly provided with hairs, which presumably have an absorptive function. Pines without mycorhiza are said to thrive quite well in humus soils. In raw humus soils a hitherto undescribed endotropic mycorhiza is found. Möller doubts if we yet know the physiological significance of mycorhiza; especially does he doubt whether it is proven that root fungi increase the supply of available nitrogen. TUBEUF,[29] on the other hand, though differing from Stahl, adheres in general to the prevalent mycorhiza theory. He thinks the chief value of the fungus to the host is in making nitrogen more available; atmospheric nitrogen in endotropic forms, humus nitrogen in ectotropic. Seven types of mycotrophic plants are recognized: (1) plants with occasional, and presumably non-essential, endotropic mycorhiza; (2) plants with strong endotropic mycorhiza, and with fully developed photosynthesis, transpiration, and absorption; (3) as in 2, except that the above-named functions are poorly developed (as Neottia), hence the fungi are probably of more consequence; (4) plants with occasional, and presumably non-essential ectotropic mycorhiza; (5) plants (as Pinus) with abundance of ectotropic mycorhiza and also of root hairs; (6) plants (Mono-

[25] GOLENKIN, M., Die Mycorhiza-ähnlichen Bildungen der Marchantiaceen. Flora **90**: 209–220. 1902.

[26] BEAUVERIE, J., Étude d'une hépatique a thalle habité par un champignon filamenteux. Compt. Rend. **134**: 616–618. 1902.

[27] CAVERS, F., On saprophytism and mycorhiza in Hepaticae. The New Phytologist **2**: 30–35. 1903.

[28] MÖLLER, A., Ueber die Wurzelbildung der ein- und zweijährigen Kiefer im märkischen Sandboden. Zeits. Forst- und Jagdwesen 1902–1903 (Bot. Centralbl. **89**: 583, **93**: 257; Bot. Zeit. **61**: 329).

[29] TUBEUF, C. VON, Beiträge zur Mycorhizafrage. Naturw. Zeits. Land- und Forstwirthschaft **1**: 67 ff., 284 ff., 1903 (Bot. Cent. **93**: 430, 520).

tropa) with ectotropic mycorhiza and no root hairs, all food-stuffs being supplied by the fungus; (7) plants with ectotropic and endotropic mycorhiza. Tubeuf discounts some of Möller's work by showing that *Pinus sylvestris* has luxuriant ectotropic mycorhiza in moors; *P. cembra* has similar root fungi in alpine humus.

Cytological mycorhiza studies have been made by SHIBATA[30] and HILTNER.[31] Shibata has confirmed the general results of W. MAGNUS,[32] and has gone into greater detail along similar lines. The infested cells of Podocarpus show enlarged and amoeboid nuclei, which divide amitotically; upon the death or resorption of the fungus ordinary mitosis occurs again, though without normal spindles and nuclear plates, the nucleus, too, soon disorganizing. Shibata agrees with Frank and Magnus that the fungus is digested by the host, in a manner analogous to the digestion of insects by carnivorous plants. He regards amitosis as another type of cell activity, not necessarily pathological. Hiltner's results agree with the above. He thinks that only certain portions of the fungus—Janse's sporangioles—are digested by the host. He regards nitrogen enrichment as proven in the case of Podocarpus.

NEGER[33] combats the well-known view of Stahl that there is a struggle for food salts in the soil between root hairs and fungi, in which the latter are most successful. Stahl supported his contention by showing that autotrophic plants grow better in sterilized soil than in soil permeated by fungi. Neger claims that this is due to the greater abundance of foodstuffs in sterilized soil. *Lepidium sativum* and *Triticum vulgare* were grown in (*a*) non-sterilized forest mold, in (*b*) similar but sterilized soil, and in (*c*) a mixture of *a* and *b*. The plants grown in *a* were far less luxuriant than in *b* or in *c*, though the roots were equally developed in all cultures. The equal development of cultures *b* and *c* shows that the presence of fungi scarcely restricts the activity of root hairs, as Stahl supposed.—H. C. COWLES.

[30] SHIBATA, K., Cytologische Studien über die endotrophen Mykorhizen. Jahrb. Wiss. Bot. **37**: 643–684. 1902.

[31] HILTNER, A., Beiträge zur Mycorhizafrage. Naturw. Zeits. Land- und Forstwirthschaft **1**: 1903 (Bot. Centralbl. **92**: 250).

[32] See BOT. GAZ. **32**: 377. 1901.

[33] NEGER, F. W., Ein Beitrag zur Mycorhizafrage: Der Kampf um die Nährsalze. Naturw. Zeits. Land- und Forstwirthschaft **1**: 372 ff. 1903 (Bot. Centralbl. **93**: 542).